S/613/61/000/014/003/019
D207/D301

24.3500

AUTHORS: Rebane, K. K., Purga, A. P., Sil'd, O. I., and Khizhnyakov, V. V.

TITLE: On the theory of electronic-vibrational transitions in crystals and molecules. II. Results of calculations for different models

SOURCE: Akademiya nauk Estonskoy SSR. Institut fiziki i astronomii. Trudy. No. 14, 1961. Issledovaniya po lyuminestsentsii, 48-75

TEXT: The authors apply the results obtained in Part I [Abstractor's note: See preceding article of this journal] to several theoretical models of vibrating systems, e.g. a luminescence center in a crystal or an isolated molecule. M. Lax's method-of-moment calculations (Ref. 1: J. Chem. Phys., 20, 1752, 1952) are used. The first four moments of an electronic vibrational band in the Condon approximation are found for the following: Single harmonic oscillator; a set of independent harmonic oscillators; a single anharmonic oscillator with anharmonicity of vibrations taken into account in

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the initial and final electronic states; a system of anharmonic oscillators with anharmonicity of the final electronic state taken into account. The Condon approximation restricts the results to the case when matrices of the electron transitions are independent of the vibrational coordinates. This restriction is removed in the latter part of the article and the authors consider (1) a single harmonic oscillator and (2) a set of independent harmonic oscillators. In case (1) the first four moments of an electronic-vibrational band are calculated with the electron matrix elements depending exponentially on the vibrational coordinate. In case (2) the first three moments of an electronic-vibrational band are calculated with the electron matrix element depending exponentially on the vibrational coordinate. Direct comparison of quantum-mechanical results for many-coordinate and quasimolecular (one or several effective coordinates) models of luminescence centers give the limits of applicability of the quasimolecular model. Acknowledgment is made to N. N. Kristofel' and I. V. Aberenkov for discussion of the results reported. There are 1 figure, 1 table and 39 references: 23 Soviet-bloc and 16 non-Soviet-bloc. The 4 most recent references to

S/613/61/000/014/003/019
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On the theory of electronic-vibrational.

the English-language publications read as follows: J. J. Markham, Rec. Mod. Phys., 31, 956 (1959); R. Knox, Phys. Rev., 115, 1095 (1959); M. Lax, Photoconductivity Conference (ed. by R. G. Breckenridge), New Yoek, 1956, p. 111; T. Kojima, J. Phys. Soc. Japan, 12, 908, 918 (1957).

SUBMITTED: July 16, 1960

B

Card 3/3

S/613/61/000/014/012/019
D207/D303

AUTHOR: Rebane, K.-S. K.

TITLE: The effect of the excitation intensity and of temperature on the steady-state luminescence brightness of ZnS-type phosphors

SOURCE: Akademiya nauk Estonskoy SSR. Institut fiziki i astronomii. Trudy. No. 14, 1961. Issledovaniya po lyuminestsentsii, 260-269

TEXT: The author presents a theory of luminescence of ZnS-type phosphors based on a band model with three trapping levels in the energy gap: Two electron levels and one hole. The steady-state is considered and it is assumed that (1) trapping levels are almost completely filled with carriers, (2) the number of hole traps is much smaller than the number of electron traps, and (3) the numbers of carriers in the conduction and valence bands are much smaller than the number of trapped carriers. Steady-state luminescence brightness and quantum yield are derived as functions of the exci-

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The effect of the excitation ...

tation intensity α and absolute temperature T for strong and weak excitations, for low and high temperatures. The number of trapped and free carriers are also found as functions of α and T. There are 1 figure and 19 references: 14 Soviet-bloc and 5 non-Soviet-bloc. The references to English-language publications read as follows: H. A. Klasens, J. Phys. Chem. Solids, 7, 175 (1958) and 9, 185 (1959); C. A. Dubce, Brit. J. Appl. Phys. Suppl., 47, 107 (1955); W. Hoogenstraaten and H. A. Klasens, J. Electromech. Soc., 100, 366 (1953).

SUBMITTED: July 2, 1960

Card 2/2

31117
S/613/61/000/014/014/019
D207/D303

9.4175 (1114, 1163, 1482)

AUTHORS: Rebane, K.-S. K., and Savikhin, F. A.

TITLE: Optical quenching and stimulation in some ZnS phosphors

SOURCE: Akademiya nauk Estonskoy SSR. Institut fiziki i astronomii. Trudy. No. 14, 1961. Issledovaniya po lyuminestsentsii, 276-280

4

TEXT: The authors report measurements of quenching and flash emission produced by additional infrared illumination during excitation of ZnS phosphors with light from a ПРК-4 (PRK-4) lamp, passed through a УФС-2 (UFS-2) filter. The following phosphors were investigated: ZnS:Zn, ZnS:Ag, ZnS:Cu (10^{-6} g/g), ZnS:Cu (10^{-5} g/g), ZnS:Cu, Al. They were prepared by heating ZnS, an activator and flux in open quartz test-tubes for 30 min at 1100°C. Infrared illumination was provided by a 400 W incandescent lamp. All measurements were carried out at room temperature. The results are presented as the degree of quenching (quenching spectrum) or the in-

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Optical quenching and ...

tensity of flash emission (flash spectrum) plotted against the infrared wavelength. The quenching spectra of the ZnS:Zn emission and of the blue luminescence of ZnS:Cu had one band at 1000-1100 mμ, which probably consisted of two closely-spaced bands. The quenching spectrum of ZnS:Ag had one band at 800-900 mμ and a stronger one at 1200-1300 mμ. The quenching spectrum of the green luminescence of ZnS:Cu had a band at 700-800 mμ and a weaker one at 1300 mμ. ZnS:Cu, Al excited with a 50 c/s field had a quenching band at 800 mμ. The results obtained for ZnS:Cu showed that: (1) The quenching and flash spectra of the same luminescence band were not identical; (2) the flash spectrum had two bands at short wavelengths: one near the maximum of optical quenching of the green band (700-800 mμ) and the other at wavelengths shorter than those investigated by the authors; (3) a flash band (at 1350 mμ) of the green and blue luminescence of ZnS:Cu (10^{-5} g/g) occurred near the long-wavelength quenching band of the green luminescence; there was no 1350 mμ flash band when the copper content in ZnS was reduced to 10^{-6} g/g. The authors state that the observed relationships could be accoun-

Card 2/3

Optical quenching and ...

ted for by a simple energy-band model. There are 2 figures and 7 references: 3 Soviet-bloc and 4 non-Soviet-bloc. The references to the English-language publications read as follows: N. T. Melamed, J. Electromech. Soc., 97, 33 (1950); E. F. Daly, Proc. Roy. Soc., 196, 554 (1949).

SUBMITTED: January 19, 1961

Card 3/3

31119
S/613/61/000/014/018/019
D207/D303

9.2574 (1144, 1055, 1163)

AUTHOR: Rebane, K. K.

TITLE: Allowance for stimulated emission by the method of moments

SOURCE: Akademiya nauk Estonskoy SSR. Institut fiziki i astronomii. Trudy. No. 14, 1961. Issledovaniya po lyuminestsentsii, 289-291

TEXT: The present note shows that the stimulated emission which is important in absorption (especially in radio frequencies) is allowed for in the formulae of the method of moments. Comparison of the expression for power absorbed by a quantum system in the dipole approximation with the formulae of the method of moments shows that the problem of finding the absorbed power integrated over frequencies, reduces to calculating the first moment of the transition probability distribution. The first-moment formula applied to an initially excited state yields negative terms in the sum over energies. These negative terms represent stimulated transitions accompanied by forced emission. Subsequent calculations

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Allowance for stimulated ...

require determination of the commutator $[Hx]$, where H is the Hamiltonian of the system and x is the coordinate operator; the result is independent of the form of the potential energy. In the case of a system represented by a Hamiltonian in which the momentum operator occurs only in the usual nonrelativistic kinetic energy operator it is found that

$$W_d = \pi N e^2 s/3mc \qquad (1)$$

where N is the number of absorbing systems; e and m are the charge and the mass of the system; c is the velocity of light; s is the density of radiation which is independent of frequency. Eq. (1) is identical with the result obtained by B. I. Stepanov and V. P. Gribkovskiy for a harmonic oscillator (Ref. 1: DAN AN SSSR, 121, 446, 1958; Izv. AN SSSR, ser. fiz., 24, 529, 1960). Eq. (1) shows how not only a harmonic oscillator, but any quantum system absorbs in the dipole approximation. The harmonic oscillator case is distinguished by absorption at a single frequency ω and, therefore,

Allowance for stimulated ...

for that oscillator Eq. (1) is also the formula for the power absorbed at the frequency ω. The method of moments can be used conveniently to find the integrated absorbed power (W_Q) in the quadrupole approximation. The problem then reduces to calculating the third moment of the transition probability distribution. Such a calculation was carried out by O. Sil'd [Abstractors note: No reference given] who obtained the following result for a linear harmonic oscillator:

$$W_d/W_Q = 16\ k\tau/5mc^2$$

where τ is the quantum temperature of the harmonic oscillator defined by $k\tau \equiv (h/2)\coth(h/2kT)$ [Abstractor's note: An abridged translation]. There are 4 Soviet-bloc references.

SUBMITTED: February 10, 1961

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4

S/058/62/000/008/052/134
A061/A101

AUTHORS: Rebane, K.-S. K., Tal'viste, E.

TITLE: Infrared quenching of brightness waves of the electroluminescence of ZnS-Cu,Al

PERIODICAL: Referativnyy zhurnal, Fizika, no. 8, 1962, 45 - 46, abstract 8V324 ("Tr. In-ta fiz. i astron. AN EstSSR", 1961, no. 15, 172 - 183; summary in English)

TEXT: The quenching factor of ZnS-Cu,Al phosphors was studied as a function of the excitation parameters during infrared irradiation of the phosphors. The excitation came from a sinusoidal electric field. A number of rules governing the behavior of the quenching factor are noted. The results are confronted with theoretical conclusions. There are 15 references.

A. Burlakov

[Abstracter's note: Complete translation]

Card 1/1

S/058/62/000/008/036/134
A061/A101

AUTHOR: Rebane, K. K.

TITLE: On the possibility of using induced emission for determining the emission bands of impurity centers

PERIODICAL: Referativnyy zhurnal, Fizika, no. 8, 1962, 26, abstract 8V182 ("Tr. In-ta fiz. i astron. AN EstSSR", 1961, no. 15, 209 - 211; summary in English)

TEXT: Attention was directed onto new possible ways, based on the phenomenon of induced emission, of studying impurity centers, particularly the possibility of determining the emission band without having to use a reference source.

[Abstracter's note: Complete translation]

Card 1/1

S/058/62/000/007/003/068
A061/A101

AUTHOR: Rebane, K. K.

TITLE: A semiclassical formula for the nonradiative transition probabilities

PERIODICAL: Referativnyy zhurnal, Fizika, no. 7, 1962, 17, abstract 7A168 ("Tr. In-ta fiz. i astron. AN EstSSR", 1961, no. 16, 49 - 56; English summary)

TEXT: Simple semiclassical formulas for estimating the nonradiative transition probabilities are presented. The semiclassical approximation in the given case consists in that some commutators are neglected in the quantum-mechanical expression obtained with the method of moments for the nonradiative transition probabilities. A preliminary discussion of accuracy and possible applications of these formulas is made.

[Abstracter's note: Complete translation]

Card 1/1

S/048/61/025/004/015/048
B104/B201

24,3500

AUTHOR: Rebane, K. K.

TITLE: Steady luminescence of ZnS phosphors as dependent upon the excitation intensity

PERIODICAL: Izvestiya Akademii nauk SSSR. Seriya fizicheskaya, v. 25, no. 4, 1961, 479-480

TEXT: The present paper has been read at the 9th Conference on Luminescence (Crystal Phosphors), Kiyev, June 20-25, 1960. The author studied a band scheme with three trapping levels, one of which being a hole level, and the other two being electron levels. The corresponding transitions are graphically presented in Fig. 1. When solving the system of equations describing the behavior of this model, the possibility of a complete filling of the hole levels was taken into account. The author examined the region of weak and medium excitations, where $n_1 + n_2 \approx n$ can be assumed, and it was also presupposed that the number of electron trapping centers be considerably higher than the number of hole trapping centers. Under

these premises, the number of ionized luminescence centers is

$$n = -\frac{1}{2}\cdot\frac{C\alpha+D}{A\alpha-B}\alpha + \sqrt{\left(\frac{1}{2}\cdot\frac{C\alpha+D}{A\alpha-B}\alpha\right)^2 - \frac{E-F\alpha}{A\alpha-B}\alpha}. \quad (1)$$

Here, α is a quantity which is proportional to the excitation intensity, A,....,F are quantities which do not depend on α as long as the escape probability for electrons and holes can be indicated in the form $W_i(\alpha, T) = W_i(T) + W_i(\alpha)$. Also the following formula is obtained:

$$N^- = \frac{\alpha + \left(W_1 - \frac{\alpha}{n_0}\right)n}{\delta_1 + \delta_2\frac{W_1}{W_2} + \beta n}. \quad (3)$$

The luminescence intensity is taken to be proportional to the number of recombinations in a luminescence center: $I = \beta n N^-$. At small α, where $W_i(T) \gg W_i(\alpha)$, n grows proportional to $\sqrt{\alpha}$. If, in addition, $(W_1 - \alpha/n_0) \gg \alpha$, and $N^- \sim \sqrt{\alpha}$, the quantum yield will be constant: $q = \beta W_1\delta/\beta_1 W\delta_1 = q_1$. With

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growing α the first term in (3) will become larger than the second, and $N^- \sim \alpha$. q then increases. As may be seen from (1) and (3), $I(\alpha)$ may rise considerably. Thus, under certain conditions, $n \sim \alpha$, and if, in addition, $W_1(T) < W_1(\alpha)$, then $I \sim \alpha^3$ and $N^- \sim \alpha^2$. Furthermore, it is easy, in the author's opinion, to show that at rising temperature $I(\alpha)$ is shifted toward higher α-values. In the range characterized by $W_i(T) < W_i(\alpha)$, I does not depend on T. Under well defined conditions, I grows with rising temperature. At an increase of α, the extinction temperature shifts toward higher temperatures. Results obtained here are in good agreement with experimental results published in the literature. In the range of strong temperature extinction, $q \approx W^{-1/2}$. If it is assumed that $W \sim \exp(-E/kT)$, where E denotes the depth of the hole trapping levels, then $q \sim \exp(E/2kT)$. In the ensuing discussion, Ch. B. Lushchik points out the importance of comparing the results obtained here with those by I. K. Vitol regarding the analogous dependence of photoelectric polarization of ZnS phosphors. Vitol had set up a hypothesis concerning a sensitized energy transfer, while the author of the present paper did without one. There are 1 figure and 12 references: 7 Soviet-bloc and 5 non-Soviet-bloc. The two

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Steady luminescence of...

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B104/B201

references to English-language publications read as follows: Ref. 5: Dubos C. A., Brit. J. Appl. Phys. Suppl. Solids., 47, 107 (1955); Ref. 10: Nail N. R., Urbach F., Pearlman D., J. Opt. Soc. America, 39, 690 (1949).

Legend to Fig. 1:
Scheme of trapping levels.

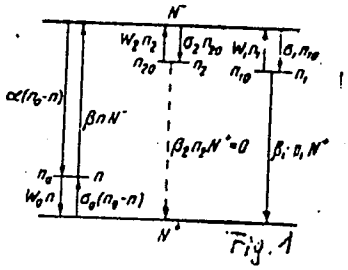

Fig. 1

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24.4500
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S/048/61/025/004/038/048
B117/B212

AUTHORS: Rebane, K. K. and Sil'd, O. I.

TITLE: Theory of electron-vibrational transitions in crystals and molecules

PERIODICAL: Izvestiya Akademii nauk SSSR. Seriya fizicheskaya, v. 25, no. 4, 1961, 535-537

TEXT: The present paper was read at the 9th Conference on Luminescence (crystal phosphors). The authors have derived the following formula to find the moment of first order of the transition-probability distribution in any quantum system: $S_l = \sum_{p=0}^{l} (-1)^p \binom{l}{p} \int (\hat{P}\Psi_n)^* \hat{H}_{II}^{l-p} \hat{P} \hat{H}_I^p \Psi_n \, d\tau$ (1), where $\hat{P}$ denotes the operator causing a disturbance of the transition; $\hat{H}_I$ and $\hat{H}_{II}$ Hamilton operator for the initial resp. final state; Ψ_n the wave function of the initial state. Results for various concrete systems, especially for atoms, molecules and crystals can be found with this formula. The

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S/048/61/025/004/038/048
B117/B212

application of formula (1) in dipole approximation for the atom at $l = 1$ will yield the known f sum rule of Thomas-Reiche-Kuhn and at $l = 2, 3, 4$ the sum rule of J. Vinti (Ref. 2: Phys. Rev., 41, 432 (1932)). Dropping the dipole approximation will result in a generalization of the results mentioned. If a molecule or a luminescence center is considered in a crystal then the adiabatic approximation is introduced. Here, formula (1) will be of the following form for the transition from an electron state n to that of n': $S_l = \sum_{p=0}^{l} (-1)^p \binom{l}{p} \int \varphi^*_{n\alpha} M^*_{n'n}(\vec{R}) \hat{H}^{l-p}_{n'} M_{n'n}(\vec{R}) \hat{H}^p_n \varphi_{n\alpha} d\vec{R}$ (2), where $\varphi_{n\alpha}$ denotes the αth wave function in an electron state n; $M_{n'n}(\vec{R})$ the electron matrix element of the $n \rightarrow n'$ transition depending on the nuclear coordinate $\vec{R}$. $\hat{H}_n$ and $\hat{H}_{n'}$ denote Hamilton operators describing the nuclear vibration in the state n, resp. n'. Averaging formula (2) with respect to the vibrational states α of the initial electron state a formula is obtained for $n \neq n'$ which corresponds to results of M. Lax (Ref. 3: J. Chem. Phys., 20, 1752 (1952)). The authors have calculated a number of various models for vibrational systems in cooperation with A. P. Purga and

S/048/61/025/004/038/048
B117/B212

Theory of electron-vibrational...

V. V. Khizhnyakov (Ref. 4: Tr. In-ta fiz. i astron. AN EstSSR, no. 14 (1961)), and by using the above formula. In order to compare theoretical and experimental results a more precise experimental determination of band contours is necessary. Quantum mechanics and other effects will appear more distinct with smaller Stokes' losses which are expressed in the vibration quantum number. Therefore, alkali-halide crystals of a low atomic weight, i.e., systems of the NaCl-Eu type, activated with rare earths, should be suitable to be used for a comparison with the theory. There are 7 references: 4 Soviet-bloc and 3 non-Soviet-bloc.

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44375

JPRS 3560

S/613/62/000/018/005/013
E039/E120

AUTHOR: Rebane, K.-S. K.

TITLE: On the theory of stationary luminescence of ZnS band to band excitation (in the host crystal absorption band)

SOURCE: Akademiya nauk Estonskoy SSR. Institut fiziki i astronomii. Trudy. no.18. 1962. Issledovaniya po lyuminestsentsii. 57-71.

TEXT: The experimental investigation of stationary luminescence of ZnS shows a number of peculiarities: 1) the intensity of luminescence does not always depend linearly on the excitation intensity; 2) the quenching temperature curve depends strongly on the excitation intensity and the wavelength of the exciting light; 3) in the majority of cases the ZnS type of phosphor is quenched on exposure to infrared or red light. In order to study possible explanations for these effects an analysis is conducted on the band model with three trapping levels for the condition of excitation in the host crystal absorption band.

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On the theory of stationary ... S/613/62/000/018/005/013
E039/E120

Some equations are also derived for the case when the exciting light produces a transfer of electrons from the activation level to the conduction band. The dependence of luminescence intensity and the concentration of trapped current carriers on intensity of excitation is similar for excitation in the host crystal and in the activator absorption band. At high intensities of excitation this dependence is different in the two cases due to the larger concentration of holes in the host crystal excitation case. Formulae are derived for the dependence of the number of ionized luminescence centres on the intensity of excitation and on the temperature.
There are 4 figures.

SUBMITTED: October 19, 1961

Card 2/2

44378
S/613/62/000/018/008/013
E039/E120

24.3500

AUTHORS: Zabotin, V.M., Rebane, K.-S.K., and Samorukov, V.Ye.

TITLE: On electro-luminescence and electro-photoluminescence

SOURCE: Akademiya nauk Estonskoy SSR. Institut fiziki i astronomii. Trudy. no.18. 1962. Issledovaniya po lyuminestsentsii. 102-106

TEXT: The coefficient of amplification (or quenching) ρ arising when an a.c. field is applied to a photo-luminescent condenser is given by:

$$\rho = (I_{э+ф} - I_э) / I_ф$$

where $I_{э+ф}$ is the intensity of electro-photoluminescence, $I_э$ the intensity of electro-luminescence, and $I_ф$ the intensity of photoluminescence. The effects of ultraviolet irradiation were investigated on the following phosphors: (1) ZnS-(10^{-3} g/g) Cu,Cl; (2) ZnS-(0.05%) Cu, (0.9%) Mn, Cl; and (3) ZnS-(0.2%) Cu, (0.05%) Al. For phosphor (1) for all values of intensity of $I_ф$ and $I_э$ and for all wavelengths of exciting light (in the range

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S/613/62/000/018/011/013
E039/E120

AUTHOR: Rebane, K.-S. K.

TITLE: On the stimulated luminescence of some luminophors

SOURCE: Akademiya nauk Estonskoy SSR. Institut fiziki i astronomii. Trudy. no.18. 1962. Issledovaniya po lyuminestsentsii. 143-144

TEXT: The stimulated spectra at different temperatures for a series of luminophors were measured. It is shown that the stimulated spectrum of SrS-Ce, Sm at low temperatures broadens. At liquid oxygen temperature a supplementary stimulation band appears on the long wavelength side of the fundamental band. This new band is stable up to a temperature of -140 °C. The stimulated spectra at different temperatures for SrS-Ce, Sm are given in the figure. A study of ZnS-Cu, Pb shows that its stimulated spectrum in the region 0.7 to 1.5 μ at the temperature of liquid oxygen consists, apparently, of three bands with maxima near 0.9, 1.23 and 1.3 μ. Their temperature behaviour confirms that one of them has a definite hole character. Moreover, this phosphor possesses weak sensitivity in the longer wavelength region of the spectrum.

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On the stimulated luminescence of ... S/613/62/000/018/011/013
E039/E120

At liquid oxygen temperature ZnS-In possesses a very intense flash, the stimulated spectrum of which is identical with the spectrum measured by H. Koelmans (J.Phys.Chem.Solids, 17, 1960, 69). The flash intensity of this phosphor decreases sharply with increasing temperature. The stimulated spectra of ZnS-Cu and (Zn.Cd)S-Cu are the same at room temperature and at liquid oxygen temperature.
There is 1 figure.

SUBMITTED: December 30, 1961.

[Abstractor's note: Complete translation.]

Card 2/3

S/613/62/000/019/002/006
B108/B186

AUTHORS: Purga, A. P., Rebane, K. K.

TITLE: Calculation of the moments of transition probabilities without applying theoretical perturbation methods

SOURCE: Akademiya nauk Estonskoy SSR. Institut fiziki i astronomii. Trudy. no. 19, 1962. Issledovaniya po teoreticheskoy fizike. 80-88

TEXT: The probabilities and moments of the probability distribution of quantum transitions are calculated for a δ-shaped disturbance

$$C\delta(t - t') = C\pi^{-1} \int_0^\infty \cos \omega(t - t')d\omega,$$

where C is an operator not depending on time and frequency. The exact probability of transition under the action of such a disturbance is $W_{if} = |\langle f|\exp\{-\frac{i}{\hbar} C\}|i\rangle|^2$. The moments are calculated with a method described by K.K. Rebane in Opt. i spektr., 9, 557, 1960, and K.Rebane, O. Sild, Proceedings of the International Conference of Semiconductor

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S/2613/62/000/021/0276/0278

ACCESSION NR: AT3013092

AUTHORS: Rebane, K. K.; Khizhnyakov, V. V.

TITLE: On the theory of the Shpolsky effect

SOURCE: AN EstSSR. Institut fiziki i astronomii. Trudy*, no. 21, 1962, 276-278

TOPIC TAGS: Mossbauer, Shpolsky effect, electron oscillation, transition, spectra, recoil energy, Stokes loss

ABSTRACT: A brief comparison has been made between the Mössbauer and Shpolsky effect (sharp lines in electron-oscillation transition spectra of impure molecules). It is contended that many quantitative relationships in the Shpolsky effect can be obtained from the corresponding formulas in the Mössbauer theory if the γ -quanta recoil energy in the latter is replaced by the Stokes loss. Certain experiments are proposed to obtain information on the degree of interaction between oscillations of various electron types in the Shpolsky effect and the existence of the Mössbauer effect on heterogeneous atoms in organic crystals.

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ACCESSION NR: AT3013092

ASSOCIATION: AN EstSSR. Institut fiziki i astronomii (AN EstSSR. Institute of Physics and Astronomy)

SUBMITTED: 22Sep62 DATE ACQ: 11Sep63 ENCL: 00

SUB CODE: PH NO REF SOV: 006 OTHER: 001

Card 2/2

S/051/62/012/002/011/020
E202/E192

AUTHOR: Rebane, K.-S. K.

TITLE: Stationary luminescence of ZnS phosphors

PERIODICAL: Optika i spektroskopiya, v.12, no.2, 1962, 254-258

TEXT: A detailed analysis of a special zone model with three trapping levels approximating closely the behaviour of many ZnS type phosphors is given. Some of the relations between the brightness of the stationary luminescence and the intensity of excitation, ambient temperature, intrinsic phosphor temperature and complementary secondary exposure to visible, ultraviolet or infrared light, are discussed. Concerned chiefly with the phenomena of electroluminescence, the author develops briefly the zone theory of stationary luminescence, considering a case in which the depth of the recombination processes of one level is considerably smaller than the remaining levels. Further simplifications are made by considering the number of hole levels considerably smaller than electron levels and selecting a case in which the number of charge carriers is much smaller than the

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number of trapped carriers. Detailed analysis of the effect of excitation intensity on the intensity of luminescence is given, isolating four regions and predicting quantum yield in each region. Finally, the effect of temperature on the intensity of luminescence is also determined. It is noted that since the temperature quenching in most of the ZnS phosphors is an external process, Mott's formula is not applicable. The experiments on temperature quenching at various excitation intensities, carried out previously by the author, confirmed this theoretical argument.
There are 3 figures.

SUBMITTED: February 23, 1961

24532

S/051/62/012/003/006/016
E202/E192

AUTHOR: Rebane, K.-S. K.

TITLE: Stationary luminescence of ZnS phosphors.
II. Electroluminescence and infrared quenching

PERIODICAL: Optika i spektroskopiya, v.12, no.3, 1962, 396-399

TEXT: Formulae developed earlier with the help of a zone model (Ref.1: Opt. i spektr. v.12, 1962, 254) and intended for the calculation of the effect of excitation intensity and temperature on the brightness of luminescence were extended in the present work to the stationary luminescence and electroluminescence, and it was shown that with their help it is possible to predict at least two, and more likely, three regions in which the luminescence intensity depends on the field potential. The results of the work of W. Lehmann (Ref.5: J.Electrochem.Soc., 103, 1956, 667) in which a formula was given embracing the experimental results relating the electroluminescence brightness to the field potential, were found also to support the general formulae developed in this work. The same

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original formulae developed from the zone model were applied also to the phenomenon of infrared quenching of electro- and photo-luminescence. The theoretical predictions were again found to be in good agreement with the experimental data. The author fully supports the hypothesis of A.M. Bonch-Bruyevich and O.S. Marenkov (Ref. 10: Opt. i spektr. v.8, 1960, 585) that in the case of infrared quenching, the electrical field not only excites the luminescence, but also quenches it.
There are 2 figures and 1 table.

SUBMITTED: February 23, 1961

REBANE, K.K.; SIL'D, O.I.

Spectroscopic sum rules taking induced emission into account.
Opt. i spektr. 13 no.4:465-470 O '62. (MIRA 16:3)
(Quantum theory)
(Absorption of light)

S/051/62/013/004/013/023
E202/E492

AUTHOR: Rebane, K.-S. K.

TITLE: Stationary luminescence of ZnS Phosphors. III

PERIODICAL: Optika i spektroskopiya, v.13, no.4, 1962, 584-587

TEXT: Having developed earlier (Opt. i spektr., v.12, 1962, 254. Tr. Inst. fiz. i astr. AN ESSR, no.8, 1962, 57) from the kinetics standpoint the formulae for the cases of activator excitation A-Z, zone-zone excitation Z-Z, and the valency zone - donor level of capture excitation Z-D, the author gives the corresponding diagrams and discusses the formulae further, justifying some of the theoretical conclusions reached by L.A.Vinokurov and M.V.Fok (Opt. i spektr., v.10, 1961, 225) (who predicted reduction of the summary luminescence value on certain determined types of levels) by measuring the dependence of the brightness of the ZnS-Cu scintillation stimulated in the 800 mμ band, on the density of the exciting light. It is shown that it is possible to determine from the summary luminescence stored in the phosphor, the depth of the levels. However, the problem is of considerable complexity and the solution may be simplified only by either

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arranging the experiment so that substantially all the electrons are localized on one type of levels or when the measurements are carried out in the far advanced stages of quenching. The work is concluded with a brief analysis of photoconductivity σ given in terms of electrons and holes mobilities, applicable to the A-Z, Z-Z and Z-D cases, showing also schematically the relation between σ and the density of excitation. The whole development is based entirely on kinetic considerations. There are 2 figures.

SUBMITTED: March 20, 1962

Card 2/2

KRISTOFFEL, N.N.; REBANE, K.K.

Some problems of the theory of luminescent centers in crystalline phosphors. Chekhosl fiz zhurnal 13 no.3:210 '63.

1. Institute of Physics and Astronomy of the Estonian Academy of Science, U.S.S.R.

KRISTOFEL', N.N.; REBANE, K.K.

Some problems of the theory of luminescence centers in crystalline phosphors. Cs cas fys 13 no.3:241-256 '63.

1. Institut fiziki i astronomii, Akademiya nauk ESSR, Tartu.

S/051/63/014/003/006/019
E039/E120

AUTHORS: Rebane, K.K., and Khizhnyakov, V.V.

TITLE: Theory of quasilinear electron-vibrational spectra in crystals. I. The theory of Shpol'skiy's effect

PERIODICAL: Optika i spektroskopiya, v.14, no.3, 1963, 362-370

TEXT: The theory of electron-vibration transitions is developed taking into account local fluctuations; in particular the effect of the Frank-Condon factor and the shape of lines with no background are investigated. It is shown that with the presence of local fluctuations in the electron-vibrational spectra in impurity centers of crystals together with bands and pure electron transition lines, dependent on crystal vibrations, there should appear a series of discrete vibration lines. This explains the Shpol'skiy effect; the occurrence of quasilinear spectra with impurity molecules in molecular crystals. Formulas are obtained showing the intensity and shape of the lines and their temperature dependence. The conditions required for the formation of quasi-linear spectra are found and the possibility of observing the intrinsic structure of quasilines is considered.

Theory of quasilinear electron- ... S/051/63/014/003/006/019
E039/E120

For this the exciton zone must be sufficiently narrow or there must be a sufficiently severe selection rule imposed on the electron transitions.

SUBMITTED: October 15, 1962

Card 2/2

REBANE, K. K.

AID Nr. 984-18 6 June

ANALOGY OF THE MÖSSBAUER AND THE SHPOLSKIY EFFECTS (USSR)

Rebane, K. K., and V. V. Khizhnyakov. Optika i spektroskopiya, v. 14, no. 4, Apr 1963, 491-494. S/051/63/014/004/007/026

A detailed comparison is presented of the thin gamma resonance lines in nuclear vibrational transitions, characteristic of the Mössbauer effect, and the thin lines of electron vibrational transitions, characteristic of the Shpolskiy effect. It is shown that by the use of the perturbation theory the two effects can be adequately described by the same formulas. This can be achieved because the mathematical properties of harmonically approximated wave functions fully eliminate the basic difference between the two treatments, which consists in postulating photon recoil energy in the Mössbauer effect and Stokes losses in the Shpolskiy effect. Along with the coincidence of such basic traits of the effects as the very thin spectral lines, the additive type of the spectrum, temperature dependence and the specific character of the influence of crystal vibrations, the analogy also encompasses the quantitative relationships of the theory. [ZL]

Card 1/1

KRISTOFEL', N.N.; REBANE, K.K.; SIL'D, O.I.; KHIZHNYAKOV, V.V.

Causes of the difference between the half-width of the absorption and emission bands of crystal phosphors. Opt. i spektr. 15 no.4:569-572 O '63. (MIRA 16:11)

LEBAILE, N. N. and MEIZHNYAKOV, V. V.

"Results from theoretical investigations of the Mössbauer effect."

The authors succeeded in discovering an analogy between Shpol'skiy's effect electron-vibrational transitions in impurity centers of ionic crystals, and the Mössbauer effect.

Report presented to the 11th Conference on Luminescence (Molecular luminescence and luminescence analysis) Minsk, 10-15 Sept. 1962.

REBANE, K.K.; KRISTOFEL', N.N. [Kristoffel, N.]; TRIFONOV, Ye.D.; KHIZHNYAKOV, V.V.

Dynamics of a lattice with impurities and the quasi-line electron-vibration spectra of crystals. Izv. AN Est. SSR. Ser. fiz.-mat. i tekh. nauk 13 no.2:87-109 '64. (MIRA 17:9)

1. Corresponding Member of the Academy of Sciences of the Estonian S.S.R. (for Rebane).

L 20543-66

ACC NR: AP6012067 SOURCE CODE: UR/0023/65/000/002/0309/0312

AUTHOR: Rebane, K.; Rebane, L.

ORG: Institute of Physics and Astronomy, AN EstSSR (Institut fiziki i astronomii AN EstSSR)

TITLE: Low-temperature emission spectra of oxygen in alkali halide crystals

SOURCE: AN EstSSR. Izvestiya. Seriya fiziko-matematicheskikh i tekhnicheskikh nauk, no. 2, 1965, 309-312

TOPIC TAGS: emission spectrum, luminescence spectrum, crystal impurity, oxygen, photomicrography, alkali halide, cryogenica

ABSTRACT: The liminescence spectra of alkali halide crystals activated by oxygen have a vibrational structure which is clearly pronounced even at room temperature. At helium temperatures each of the vibrational bands of the spectrum is found to possess a "fine structure." In order to study this structure further and ascertain its nature, the authors made a more detailed measurement of luminescence spectra at a temperature of 4.2° K. The authors report finding a number of new spectra details (from three to ten clear peaks) and attribute the fine structure mainly to the interaction of the electron transition in the impurity molecule O_2^-, with the crystal vibrations distorted by it. The article presents photomicrograms of the emission spectra of NaBr - O_2, KCl - O_2, and KBr - O_2, as well as a table of the positions of all recorded peaks. The authors thank Ye. F. Gross and coworkers at the laboratory

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L 20543-66
ACC NR: AP6012067

for making possible the carrying out of the measurements. Further thanks is extended to B. P. Zakharchene for valuable advice and to I. I. Takhistovaya for participation in the measurements. Orig. art. has: 3 figures and 3 tables. [JPRS]

SUB CODE: 20 / SUBM DATE: 08Jun65 / ORIG REF: 003 / OTH REF: 006

Card 2/2

L 23516-66 EWT(l)/T IJP(c) GG
ACC NR: AT6008330 SOURCE CODE: UR/2613/64/000/027/0017/0022

AUTHOR: Rebane, K. K.; Tekhver, I. Yu.; Khizhnyakov, V. V.

ORG: none

43
B+1

TITLE: Detailed structure of a purely electronic quasi-line

SOURCE: AN EstSSR. Institut fiziki i astronomii. Trudy, no. 27, 1964. Issledovaniya po teorii tverdogo tela (Research on the theory of solids), 17-22

TOPIC TAGS: crystal theory, impurity center, Mossbauer effect, line spectrum, line width, vibration spectrum, crystal impurity

ABSTRACT: The authors study the theoretical width of an extremely narrow purely electronic quasi-line in vibrational electron spectra of impurity crystals. Two cases are considered: 1. the impurity centers are assumed to be ideally identical, 2. the impurities are assumed to be in slightly different conditions due to nonuniformity in the structure of the crystal matrix. The second case corresponds to actual experimental conditions. The theoretical similarities between the purely electronic quasi-line and the Mössbauer line are discussed. It is shown that the purely electronic line in the vibronic spectrum of an impurity crystal may have a width of the order of the radiation width, at least at low temperatures, i. e. of the order of 10^{-4} cm^{-1} for allowed transitions. This line is narrow enough to be lost through statistical dispersion due to nonhomogeneities in the crystal matrix in ordinary experimental condi-

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ACC NR: AT6008330

tions. An experimental study of the shape of these lines will require improvement in experimental techniques to eliminate the effect of nonhomogeneities in the crystal on the purely electronic energy of impurities. Orig. art. has: 1 formula.

SUB CODE: 20/ SUBM DATE: 20Nov63/ ORIG REF: 011/ OTH REF: 003

Card 2/2

L 23515-66 EWT(l)/T IJP(c) GG
ACC NR: AT6008331 SOURCE CODE: UR/2613/64/000/027/0023/0056

AUTHOR: Rebane, K. K.; Sil'd, O. I.; Tekhver, I. Yu.

57
B+1

ORG: none

TITLE: Vibrational electron bands of a luminescence center with regard to anharmonicity of vibrations

SOURCE: AN EstSSR. Institut fiziki i astronomii. Trudy, no. 27, 1964. Issledovaniya po teorii tverdogo tela (Research on the theory of solids), 23-56

TOPIC TAGS: luminescence center, crystal theory, energy band structure , harmonic analysis, vibration spectrum, vibration

ABSTRACT: The authors calculate the moments S_l for probability distribution of vibronic transitions of order l = 0, 1, 2, 3 and 4 for a luminescence center in a crystal. The adiabatic potentials of the ground and excited electron levels of the luminescence center are given in the form of expansions in power series including anharmonic of the third and fourth orders. The electron matrix element is accounted for as a function of the vibrational coordinates together with the anharmonicity of the adiabatic potentials. Some of the results are compared with experimental data in the literature. An analysis of the resultant expressions for the moments indicate that vibrational anharmonicity may be definitive in the following effects: 1. a temperature

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ACC NR: AT6008331

shift in the first moment of the band; 2. a deviation in the temperature relationship of the half-width of the band δ from the law $\delta \sim \sqrt{T}$; 3. the sign of asymmetry of the band. The basic effect which shows the relationship between M and the vibrational coordinates is an increase in the intensity of the integral band with temperature. This relationship does not show up in any other clearly pronounced singularities in the behavior of a band corresponding to a center where the Stokes losses are high. Orig. art. has: 16 formulas.

SUB CODE: 20/ SUBM DATE: 06Nov63/ ORIG REF: 045/ OTH REF: 021

Card 2/2

L 23692-66 EWT(1) IJP(c) WW/GG

ACC NR: AR6005200 SOURCE CODE: UR/0058/65/000/009/D034/D034

AUTHORS: Rebane, K. K.; Tekhver, I. Yu.

TITLE: Contribution to the theory of Raman scattering of light by an impurity crystal

SOURCE: Ref. zh. Fizika, Abs. 9D277

REF. SOURCE: Tr. In-ta fiz. i astron. AN EstSSR, no. 29, 1964, 54-65

TOPIC TAGS: Raman scattering, light scattering, impurity scattering, crystal impurity, electron spectrum, vibration spectrum, line spectrum, operator equation, matrix element

TRANSLATION: The authors consider two methods of summation over the intermediate states in the formula for electron-vibration Raman scattering of light by impurity crystals, namely the method of quantum-mechanical sum rules and the method of ordered operators. The previously drawn conclusions concerning the quasi-line structure of the spectrum have been confirmed. It is shown that at scattering-

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L 23517-66 EWT(1)/T IJP(c) GG
ACC NR: AT6008329 SOURCE CODE: UR/2613/64/000/027/0003/0016

AUTHOR: Rebane, K. K.; Trifonov, Ye. D.; Khizhnyakov, V. V.

ORG: none

TITLE: Quasi-line vibrational electron spectra and their relationship to the Mössbauer effect

SOURCE: AN EstSSR. Institut fiziki i astronomii. Trudy, no. 27, 1964. Issledovaniya po teorii tverdogo tela (Research on the theory of solids), 3-16

TOPIC TAGS: line spectrum, vibration spectrum, Mossbauer effect, crystal theory, cadmium sulfide, crystal impurity, electron spectrum, temperature dependence

ABSTRACT: The authors briefly review the literature on the theory of quasi-line vibrational electron spectra in impurity crystals. Fundamental formulas are given which describe vibrational electron spectra and their relationship to temperature. The theoretical conclusions are compared with experimental data for the 488.6 angstrom line in a cadmium sulfide crystal. Experimental curves for the temperature relationship of the CdS emission spectrum near this line show qualitative confirmation of the theoretical conclusions. The ratio of the integral intensity of the pure electron line to that of the phonon section of the curve (due here to acoustic vibrations of the lattice) falls rapidly with an increase in temperature. The distribution of Stokes

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ACC NR: AT6008329

losses shows a maximum at approximately 6 cm^{-1}, i. e. the strongest interaction is with vibrations having a wavelength of 10-20 lattice constants. A great similarity is observed between the Mössbauer effect and quasi-line vibrational electron spectra. The main difference between the two phenomena is that recoil energy is of prime importance in the Mössbauer effect while Stokes losses play the leading role in quasi-line vibrational electron spectra. The second approximation of perturbation theory is sometimes required for explaining the Mössbauer effect with respect to the natural width of the excited level. Orig. art. has: 2 figures, 1 table, 6 formulas.

SUB CODE: 20/ SUBM DATE: 01Nov63/ ORIG REF: 029/ OTH REF: 010

Card 2/2

L 41023-66 EWT(m)/EWP(t) /ETI IJP(c) JD
ACC NR: AP6019653 SOURCE CODE: UR/0368/66/004/006/0529/0534

AUTHOR: Pae, A.; Rebane, K. S.; Piyr, K.

58
3

ORG: none

TITLE: Luminescence of ZnS-$AgAlS_2$

SOURCE: Zhurnal prikladnoy spektroskopii, v. 4, no. 6, 1966, 529-534

TOPIC TAGS: zinc sulfide optic material, luminescence, emission spectrum, spectrographic analysis

ABSTRACT: The luminescence of ZnS-$AgAlS_2$ phosphors was investigated. To prepare $AgAlS_2$, Ag_2S and Al_2S_3 were mixed in a dry form and heated in an evacuated sealed quartz ampule at 850—950C for 12 hr. To prepare the ZnS-$AgAlS_2$ the powder of ZnS was preliminarily heated in a flow of H_2S at 450C for 1 hr, mixed with $AgAlS_2$ and heated for 4.5 hr at 1150C. The concentration of $AgAlS_2$ varied from $5 \cdot 10^{-5}$ to 1.0 mol %. The emission spectra were measured by a monochromator and photomultiplier and the excitation spectra by spectrophotometers. The emission spectrum of ZnS-$AgAlS_2$ revealed three bands with peaks of about 2.8 (blue band), 2.4 (green band), and 2.0 eV (red band). However, all these bands were evident only at low concentrations of $AgAlS_2$ in the phosphor. The blue band dominated

UDC: 535.37

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L 41023-66
ACC NR: AP6019653

at higher concentrations of the activator. The excitation spectra consisted of three characteristic regions: 1) encompassed the group of peaks found within the absorption limits of the main lattice of ZnS; 2) contained only one characteristic band near the fundamental absorption edge (this band at 77K was at about 3.8 eV); and 3) encompassed all excitation bands, the peak energy of which was less than 3.8 eV. The most interesting of them were the excitation bands of green luminescence at about 3.00 eV and red luminescence at about 2.63 eV. It was found that the peaks of the emission bands shift to the longwave side when the concentration of $AgAlS_2$ and the temperature are increased. It is postulated that the excitation band at 3.80 eV is due to absorption of the exciting light by S^{2-} ions surrounding the activator ion. The red emission band was explained by means of the donor-acceptor model of luminescence. Orig. art. has: 3 tables and 3 figures.

SUB CODE: 11,20/ SUBM DATE: 30Jun65/ ORIG REF: 009/ OTH REF: 007

Card 2/2 hs

L 10391-67 EWT(1) IJP(c)
ACC NR: AP7003065 SOURCE CODE: UR/0023/66/000/002/0299/0301

25

AUTHOR: Rebane, K.; Sil'd, O.

ORG: Institute of Physics and Astronomy, Academy of Sciences Estonian SSR (Institut fiziki i astronomii AN EstSSR)

TITLE: Theory of the vibrational structure of the spectrum of a light impurity molecule

SOURCE: AN EstSSR. Izvestiya. Seriya fiziko-matematicheskikh i tekhnicheskikh nauk, no. 2, 1966, 299-301

TOPIC TAGS: luminescence spectrum, adiabatic approximation

ABSTRACT: An article by L. REBANE and T. SAAR in the same issue of this journal establishes the fact that there is a decrease in the half-width of the vibration sub-band of KBr-O_2^- with an increase in the number n in the luminescence spectrum. The present article is intended to show that this fact may be explained as the effect of the interaction of local vibration with crystal vibrations if the "double adiabatic approximation" is used as the basis and a certain assumption is made as to the sign of an harmonic interaction between local and crystal vibrations. The authors note that the "double adiabatic approximation" is a general approach to the problem of a comparatively light impurity molecule in a heavy base and is apparently also effective in the case of any impurity centers if there is a local vibration with a frequency significantly exceeding the frequency of the remaining vibrations. The authors state that they hope to return to a detailed consideration of the "double adiabatic approximation" in subsequent publications. Orig. art. has: 3 formulas. [JPRS: 39,040]

SUB CODE: 20 / SUBM DATE: 03Mar66 / ORIG REF: 004

Card 1/1 SB

L 8212-66 EWT(m)/EWP(t)/EWP(b) LIP(c) JD

ACC NR: AP5013860 SOURCE CODE: UR/0368/65/002/004/0350/0355

AUTHOR: Rebane, K.-S. K.; Ruttas, V. I.

ORG: none

TITLE: Effect of the activator on the infrared stimulation and quenching spectra of ZnS luminophors

SOURCE: Zhurnal prikladnoy spektroskopii, v. 2, no. 4, 1965, 350-355

TOPIC TAGS: crystal phosphor, zinc sulfide, IR spectrum, luminescence quenching, luminescence spectrum

ABSTRACT: The authors examine the IR stimulation and quenching spectra of unactivated zinc sulfide and of zinc sulfide activated by copper, silver and gold. The de-excitation curves of the phosphors are measured at 77 and 293°K. The methods used for synthesis and excitation of the specimens are described briefly. The luminophors studied (with the exception of ZnS) have four main thermoluminescence maxima: at roughly -170, -130, -40 and +30°C. It may be assumed that some of these peaks are made up of two or more components. The absence of a thermomaximum at ~30°K in ZnS is attributed to temperature quenching. Luminescence stimulation spectra for the various phosphors studied are given in the 0.85-3.00 μ range. ZnS gave the most intense scintillation and ZnS-Cu gave the least intense scintillation. Five groups of

UDC: 535.373.2

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ACC NR: AP5013860

levels are observed in the stimulation spectrum which correspond to definite capture levels. The approximate maxima for these bands are located at energy levels of 1.4-1.3, 1.0, 0.8, 0.55 and 0.45 ev. The most intense of these is the maximum at about 1.0 ev. The relative intensity (but not the position) of the other bands depends on the activator. The 1.0 ev band has the simplest structure in ZnS-Cu. For the other phosphors, this band is wider and has a more complex structure. The IR quenching spectra show up best at room temperature. These spectra are extremely sensitive to the type of activator. The edge of the quenching region for both gold- and copper-activated ZnS lies at about 1.1-1.2 ev (at 77°K). The edge of the IR-sensitive region for ZnS-Ag lies at a temperature of about 0.8 ev for a temperature of 293°K. The sensitivity edge for IR-quenching in ZnS phosphor lies at about this same level. A comparison of stimulation and quenching spectra at the two temperatures indicates that both types of spectrum are extremely sensitive to temperature. A band model is proposed to explain the quenching spectra for the various phosphors studied. Bands observed in the stimulation spectrum are attributed to lattice defects. Orig. art. has: 3 figures.

SUB CODE: OP,SS/ SUBM DATE: 27Sep64/ ORIG REF: 005/ OTH REF: 003

nw

Card 2/2

ACC NR: AP7004996 SOURCE CODE: UR/0048/66/030/009/1537/1538

AUTHOR: Robano, K.-S. K.

ORG: none

TITLE: Influence of reabsorption on the kinetics of equilibrium emission of ZnS type phosphors /Report, Fourteenth All-Union Conference on Luminescence (Crystal Phosphors) held at Riga, 16-23 Sept. 1965/

SOURCE: AN SSSR. Izvestiya. Seriya fizicheskaya, v. 30, no.9, 1966, 1537-1538

TOPIC TAGS: luminescence, luminescent crystal, zinc sulfide, light absorption, light emission, ~~feedback~~, luminescence center, mathematic physics

ABSTRACT: The author briefly reviews the literature on reabsorption in luminophors. Reabsorption can take place only when the emission spectrum of the luminophor overlaps the absorption spectrum. Such overlap takes place in ZnS:Cu:Co phosphors. Reabsorption can considerably affect the equilibrium emission from a thick layer of luminescent material. This effect was calculated on the basis of a simple band model with one donor and one acceptor level, and the resulting equilibrium concentrations of ionized luminescence centers and conduction electrons for the cases of reabsorption at a) electron-trapping centers, b) un-ionized luminescence centers, and c) filled hole-trapping centers, are presented in terms of a notation introduced elsewhere by the author (Tp. In-ta fiziki i astron. AN EstSSR, No.10, 209 (1959)) and only partly

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ACC NR: AP7004996

explained in the present paper. In case a) the reabsorption limits the growth of the stored light sum and can contribute to the linearity of the photoconductivity and photoluminescence. In case b) the reabsorption increases both the light sum and the current carrier concentration. In case c), for which the current carrier concentration is not given, owing to the complexity of the calculations, reabsorption reduces the light sum. It would be desirable experimentally to establish the reality of the deduced effects. Orig. art. has: 5 formulas and 1 figure.

SUB CODE: 20 SUBM DATE: none ORIG. REF: 007 OTH REF: 002

Card 2/2

REBANE, K.K.E.; RUTTAN, V.L.

Effect of an activator on the infrared spectra of stimulation and quenching of ZnS prosphors. Zhur.prikl. spekt. 2 no.4:359-365 Ap '65. (MIRA 18:8)

L 64710-65 EWT(1) IJP(c)

ACCESSION NR: AR5012267 UR/0058/65/000/003/D041/D042

SOURCE: Ref. zh. Fizika, Abs. 3D314

AUTHOR: Preem, R. A.; Purga, A. P.; Rebane, K. K.; Trifonov, Ye. D.; Khizhnyakov, V. V.

TITLE: Quasi-line electron vibrational spectra and their relationship to the Mössbauer effect

CITED SOURCE: Tr. Komis. po spektroskopii. AN SSSR, vyp. 1, 1964, 38-51

TOPIC TAGS: Mossbauer effect, vibration spectrum, electron spectrum, line spectrum, crystal vibration, Raman scattering

TRANSLATION: A short survey is given of theory which considers quasi-line electron vibrational spectra (the Shpol'skiy effect, impurities in ionic crystals) and "nuclear vibrational" spectra (the Mössbauer effect and its analogies) from a single point of view. Particular attention is given to new results on the following problems: 1) effect of temperature on quasi-line spectra with regard to local oscillations, narrow vibrational zones and sharp maxima in the distribution of Stokes losses or output energy from crystal vibrations; 2) local and quasi-stationary vibra-

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ACCESSION NR: AR5012267

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tions around an impurity, quasi-line contour and nature of vibrational relaxation; 3) possibility for the existence of a second (broad) resonance near the phonon-free line; 4) quasi-line spectra of Raman scattering by local vibrations.

SUB CODE: SS ENCL: 00

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Card 2/2

L 60919-65 EWT(1) IJP(c)

ACCESSION NR: AT5013530 UR/2613/64/000/026/0025/0037

17
B+1

AUTHORS: Rebane, K. K.; Sil'd, O. I.

TITLE: The Franck-Condon principle and the Mossbauer effect 21

SOURCE: AN EstSSR. Institut fiziki i astronomii. Trudy, no. 26, 1964, Issledovaniya po lyuminestsentsii (Research on luminescence), 25-37

TOPIC TAGS: Franck-Condon principle, Mossbauer effect, electron vibrational transition, nuclear vibrational transition, Mossbauer line intensity

ABSTRACT: The purpose of the article is to reformulate the Franck-Condon principle (FCP) in a manner making it possible to apply it to several problems connected with the Mossbauer effect. To this end, an analysis is presented of the FCP with allowance for the recoil momentum and for the change in the mass of the nucleus. The effect of the recoil energy on the probability of nuclear-vibrational transitions is then analyzed, using a very simple model of vibrational

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L 60919-65

ACCESSION NR: AT5013530

system consisting of a single harmonic oscillator. This is equivalent to analyzing the Mossbauer effect with the aid of the FCP on the basis of a quasimolecular model for a single normal oscillation mode. Special emphasis is placed on the FCP concept that the momentum of the vibrating system decreases by an amount equal to the radiated photon momentum or increases by the amount of the absorbed photon momentum. The analysis shows that the FCP can be successfully used for a qualitative interpretation of the Mossbauer effect, and is also useful for a rough estimate of the integral intensity of the Mossbauer line. The main features of the Mossbauer effect can be easily understood by supplementing the FCP concepts with an analysis of the factors affecting the width of the lowest vibrational state of the system. Orig. art. has: 4 figures and 10 formulas

ASSOCIATION: Institut fiziki i astronomii AN EstSSSR (Institute of Physics and Astronomy, AN EstSSSR)

SUBMITTED: 15Jun63 ENCL: 00 SUB CODE: NP, GP

NR REF SOV: 012 OTHER: 010

dm

Card 2/2

L 59211-65 EWT(1)/T/EEC(b)-2 Pi-4 IJP(c) GG

ACCESSION NR: AR5017538 UR/0058/65/000/006/D040/D040

20
B

SOURCE: Ref. zh. Fizika, Abs. 6D295

AUTHORS: Rebane, K. K.; Tekhver, I. Yu.; Khizhnyakov, V. V.

TITLE: Detailed structure of the purely electronic quasi-line

CITED SOURCE: Tr. In-ta fiz. i astron. AN EstSSR, no. 27, 1964, 17-22

TOPIC TAGS: purely electronic quasiline, line structure, electron vibrational spectrum, impurity center, quantum beat procedure

TRANSLATION: The authors consider the structure of the purely-electronic quasiline (PEL) in electron-vibrational spectra of impurity crystals in two cases: 1) the impurity centers (IC) are in ideally identical conditions (theoretical spectrum); 2) the IC are in slightly different conditions as a result of inhomogeneity of the crystal matrix (the spectrum corresponds to conditions of the existing experiment). It is indicated that at low temperatures the PEL can have a width on the order of the radiation width ($\sim 10^{-4}$ cm^{-1}). It is proposed to investigate the form of the PEL using the quantum beat procedure (RZhFiz, 1964, 4D157), which eliminates the influence of the inhomogeneities of the crystal on the purely-electronic energy of the impurities.

SUB CODE: OP ENCL: 00

Card 1/1 lm

REBANE, K.K.

Theory of the interaction between transitions in the electron shell and nucleus of an impurity and the vibrations of a crystal. Opt. i spektr. 16 no. 4:594-601 Ap '64. (MIRA 17:5)

ACCESSION NR: AP4043031 S/0023/64/000/002/0087/0109

AUTHORS: Rebane, K. K.; Kristofel', N. N.; Trifonov, Ye. D.; Khizhnyakov, V. V.

TITLE: Dynamics of a lattice with impurities and quasi-line electron-vibration spectra of crystals

SOURCE: AN EstSSR. Izv. Seriya fiziko-matematicheskikh i tekhnicheskikh nauk, no. 2, 1964, 87-109

TOPIC TAGS: crystal lattice vibration, impurity spectrum, electron spectrum, line spectrum, crystal lattice theory, Mossbauer effect, Raman scattering

ABSTRACT: This survey article brings up to date an earlier report (N. N. Kristofel' and K. K. Rebane, Fizika shchelochno-galoidny*kh kristallov [Physics of Alkali-Halide Crystals] Riga, 1962, p. 32) in light of three major developments that have occurred during the

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ACCESSION NR: AP4043031

elapsed time. The first is the progress in the theory of crystal-lattice dynamics, particularly the character of distortion of the crystal lattice near impurities, which has made it possible to predict various types of oscillations in electron-vibration and related processes. The second is the application of the Mossbauer effect to the study of local lattice dynamics. The third is the better understanding of the closed connection between the interaction with electron-transition vibrations and the analogous problem of gamma transitions in an atomic nucleus contained in the crystal (optical analog of the Mossbauer line and the Shpol'skiy effect). In addition, the number of experimental researches on the direct study of dynamics of the lattice near crystal defects, including local oscillations, has greatly increased during the past few years. It is pointed out in the conclusions that principal interest attaches to further development of the theory of the purely electronic line and performance of exact experiments aimed at ascertaining how narrow they can be and how close the analogy between the Mossbauer line

ACCESSION NR: AP4043031

and the purely electronic line actually is. Further development of the theory of vibrations of impurity molecules in crystals and further research with the aid of the Mossbauer effect are urged. The section headings are: 1. Introduction. 2. Local and pseudolocal oscillations. 3. Electron-vibration transitions and local lattice dynamics. 4. Raman scattering of light. 5. Infrared absorption spectra. 6. Mossbauer effect and a few other phenomena. 7. Concluding remarks. Orig. art. has: 2 figures, 2 formulas, and 1 table.

ASSOCIATION: None

SUBMITTED: 12Mar64 ENCL: 00

SUB CODE: OP, SS NR REF SOV: 066 OTHER: 068

Card 3/3

L 60904-65 EWT(1) LJP(c)
ACCESSION NR: AT5013543 UR/2613/64/000/026/0194/0202

AUTHORS : Kalder, Kh. Ya. Rebane, K.-S.K.

TITLE: Dependence of infrared quenching on the firing temperature of a luminor

SOURCE: AN EstSSR. Institut fiziki i astronomii. Trudy, no. 26, 1964. Issledovaniya po lyuminestsentsii (Research on luminescence), 194-202

TOPIC TAGS: infrared quenching, infrared spectrum, infrared sensitive luminor, zinc sulfide optical material

ABSTRACT: Data are presented on the luminescence brightness, infrared quenching coefficient, infrared quenching spectra, and the dependence of the infrared quenching on the intensity of the infrared light, all as functions of the firing temperature (from 400 to 1150C) of ZnS-Cu phosphors. The copper was introduced in the form of a sulfate, nitrate or chloride salt. The compounds were fired for 30 minutes in sealed

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L 60904-65
ACCESSION NR: AT5013543

ampoules made of refractory glass or in open quartz test tubes. The quenching spectra were measured with a spectrometer and normalized to equal intensity of applied infrared light. The results show that the luminescence brightness of ZnS increases exponentially with increasing firing temperature in the 400 -- 800C range. The infrared quenching factor μ is increased only in the temperature region 400 -- 500C. The dependence of the light sum on the firing temperature differs from the dependences of the brightness and of the quenching factor. Plots of the quenching against the infrared radiation intensity and of the spectral distribution of the infrared quenching against the firing temperature are also presented. It is deduced from the experimental results that the luminor properties are due not only to the diffusion of the activator, but also to the changes which take place in the crystal lattice was a result of firing. In particular, at low temperature the crystallization is not complete and a large amount of non-crystallized material is produced near the activating impurity. 'The authors thank A. F. Malysheva for supplying the sublimated luminor ZnS-Cu.' Orig. art. has: 3 figures and 2 tables.

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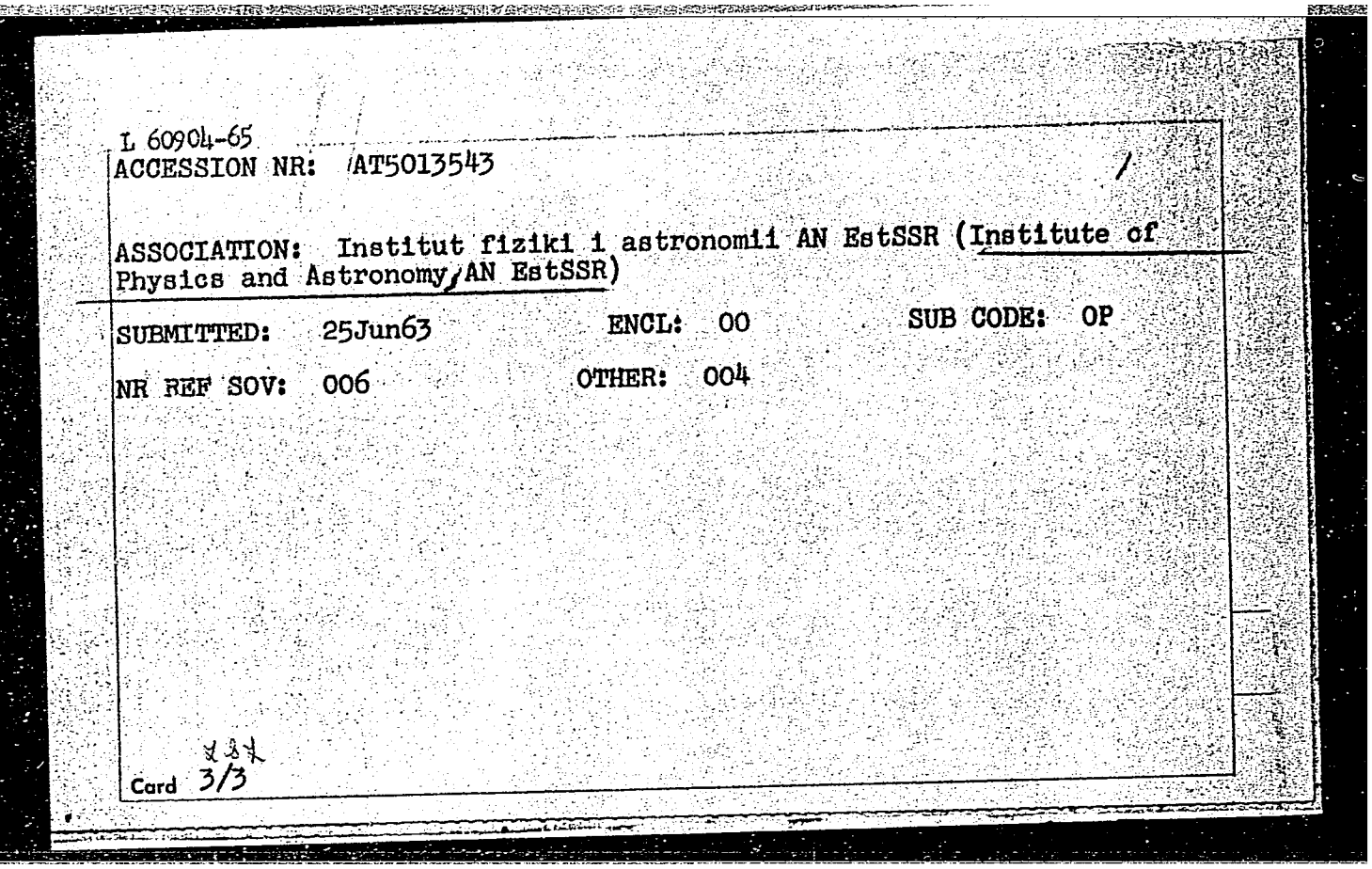

L 60904-65
ACCESSION NR: AT5013543

ASSOCIATION: Institut fiziki i astronomii AN EstSSR (Institute of Physics and Astronomy, AN EstSSR)

SUBMITTED: 25Jun63 ENCL: 00 SUB CODE: OP

NR REF SOV: 006 OTHER: 004

Card 3/3

S/0051/64/016/004/0594/0601

ACCESSION NR: AP4032864

AUTHOR: Rebane, K.K.

TITLE: Contribution to the theory of interaction of transitions in the electron shell and atomic core of an impurity with vibrations of the crystal lattice

SOURCE: Optika i spektroskopiya, v.16, no.4, 1964, 594-601

TOPIC TAGS: phonon transition interaction, Mossbauer effect, Shpol'sky effect, impurity spectrum, Stokes loss, vibronic spectrum

ABSTRACT: The paper is an attempt to develop a unified approach to treatment of electronic-vibrational spectra (the Shpol'sky effect - appearance of line spectra of organic and other solutes in frozen paraffin solutions at cryogenic temperatures - and impurity spectra in ionic crystals) and nucleo-vibrational spectra (the Mossbauer effect). It is recalled that the shape of the spectrum lines of impurities lodged in crystals depends to a certain extent on the interaction between the associated transitions in the impurity atoms and the vibrations of the crystal lattice. The problem of the distribution of the gamma-photon recoil energy over the vibrational degrees of freedom of the crystal can be treated in the momentum appro-

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ACCESSION NR: AT4020792 S/2613/63/000/023/0018/0021

AUTHOR: Rebane, K. K.; Sil'd, O. I.

TITLE: The theory of stimulated transitions in electron-vibrational bands

SOURCE: AN EstSSR. Institut fiziki i astronomii. Trudy*, no. 23, 1963. Issledovaniya po lyuminestsentsii (Research in luminescence), 18-21

TOPIC TAGS: electron vibration, electron band, electron transition, stimulated electron transition

ABSTRACT: Pointing out that, in previous works, attention has already been directed at the possibility of using the electron-vibrational transitions in the impurity centers of a crystal for the generation of light, the authors note that in these studies no allowance was made for the overlapping of the absorption and emission bands. The purpose, therefore, of this brief article is to provide in a clear form the existence criteria of negative temperatures at electron-vibrational band frequencies for a luminescence center in the crystal, the aforementioned overlapping being taken into account:

$$\frac{N_{II}}{N_I}\frac{Z_I}{Z_{II}}\exp\frac{\hbar\omega_0-\hbar\omega}{kT}>1,$$

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ACCESSION NR: AT4020792

The model considered (two electron levels, each having its own set of vibrational levels) is roughly equivalent to a four-level system, from the point of view of induced emission. A more accurate equivalent is a system with two infinite sets of levels, in which vibrational level relaxation until thermal equilibrium occurs with infinite speed. "The authors are grateful to B. I. Stepanov for his valuable advice, and also to A. P. Purga and V. V. Khizhnyakov for their discussion of the work." Orig. art. has: 4 formulas.

ASSOCIATION: Institut fiziki i astronomii AN EstSSR (Institute of Physics and Astronomy AN EstSSR)

SUBMITTED: 01Oct62 DATE ACQ: 07Apr64 ENCL: 00

SUB CODE: PH NO REF SOV: 003 OTHER: 001

Card 2/2

ACCESSION NR: AT4020805 S/2613/63/000/023/0200/0209

AUTHOR: Rebane, K.-S. K.; Tal'viste, E. K.

TITLE: The effect of infrared radiation on the electroluminescence of ZnS-Cu, Al, excited with square-wave voltage of ultralow frequency. Part II.

SOURCE: An EstSSR. Institut fiziki i astronomii. Trudy*, no. 23, 1963. Issledovaniya po lyuminestsentsii (Research in luminescence), 200-209

TOPIC TAGS: luminescence, electroluminescence, phosphor, ZnS-Cu, Al phosphor, ultralow frequency luminescence, infrared radiation, infrared quenching

ABSTRACT: Electroluminescence has recently been widely used in various branches of electronics, particularly for the conversion of various electrical pulses into light pulses. When using such converters, it is of great importance to know the kinetics of the conversion process. The kinetics of the luminescence produced by the excitation of phosphors with different square-wave pulses has already been rather well studied (G. R. Hoffman, D. H. Smith, J. Electron. and Control, 9, 161, 1960). In the present paper, however, the authors used bipolar voltage pulses of ultralow frequency (10^{-2} - 10^{2} cycles). In addition, they studied the effect of infrared light on the electroluminescence brightness waves. The methodology and equipment employed in this research has previously been

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ACCESSION NR: AT4020805

described (K.-S. K. Rebane, E. K. Tal'viste, Trudy* IFA AN ESSR, no. 21, 257, 1962). The authors considered the form of the brightness waves of electroluminescence under permanent and stroboscopic infrared irradiation ($\lambda = 0.7 - 1.2\ \mu$) and without it. Under the effect of IR light the build-up time of the brightness wave, excited with ultralow-frequency square-wave voltage pulses, decreases. A decrease is also observed in the duration of the brightness wave. The IR quenching factor increases during the build-up of the brightness wave. During the attenuation of the brightness wave the IR quenching factor is quite large and shows little dependence on the rate of attenuation. Two hypotheses are proposed to explain the phenomena observed: competition between the quenching effect of the electrical field and the effect of the IR light, or the monomolecular character of the glow during the time the glow builds up. The authors state that at the present time there are insufficient experimental data to make it possible to choose between these two possible causes for the reduction of IR quenching in the build-up region of electroluminescence brightness waves; it is quite possible, moreover, that both mechanisms exist simultaneously. Orig. art. has: 5 figures.

ASSOCIATION: Institut fiziki i astronomii AN EstSSR (Institute of Physics and Astronomy, AN EstSSR)

SUBMITTED: 12Jul62 DATE ACQ: 07Apr64 ENCL: 00

SUB CODE: PH NO REF SOV: 005 OTHER: 001

Card 2/2

REBANE, K. K.; TRIFONOV, Ye. D.; KHIZHNYAKOV, V. V.;

?

"Quasi-Linear Electron-Vibrational Spectra and their Relation to the Messbauer Effect."

report submitted to 11th Intl Spectroscopy Colloq, Belgrade, 30 Sep-4 Oct 63.

AUTHOR: Rebane, Kh. SOV/26-58-12-41/44

TITLE: The Japanese Hamamelis, a Shrub Flowering in Winter (Yaponskiy Gamamelis - kustarnik, tsvetushchiy zimoy)

PERIODICAL: Priroda, 1958, Nr 12, p 126 (USSR)

ABSTRACT: Of the Hamamelis family, only Parrotia persica is a native tree on Soviet territory; it is found in the Talysh forests of the Azerbaydzhan SSR. Except for Hamamelis virginiana, there is little known about other acclimated representatives of this family in the forest belt of the USSR. But the tree and shrub exhibition site of the "Yarvsel'ya" training forestry of the Estonskaya sel'skokhozyaystvennaya akademiya (Estonian Agricultural Academy) in the Ryapinskiy Rayon of the Estonian SSR is displaying shrubs of Hamamelis japonica which flower annually between December and February at temperatures ranging up to - 26.7°C. The shrubs were raised from seeds obtained from Denmark. They do not bear fruit or seeds. There is 1 British reference.

ASSOCIATION: Uchleskhoz "Yarvsel'ya" (The "Yarvsel'ya" Training Forestry)

Card 1/1

REBANE, K.; REBANE, T., kand. fiz.-matem. nauk

Theory of Raman scattering of light by molecules. Izv. AN Est. SSR. Ser. fiz.-mat. i tekh. nauk 12 no.3:227-237 '63. (MIRA 16:11)

1. Institute of Physics and Astronomy of the Academy of Sciences of the Estonian S.S.R. and Leningrad State University.
2. Corresponding Member of the Academy of Sciences of the Estonian S.S.R. (for K. Rebane).

ACCESSION NR: AT4020806 S/2613/63/000/023/0210/0215

AUTHOR: Rebane, K.-S. K.; Tal'viste, E. K.

TITLE: The build-up of ultra low-frequency electroluminescence

SOURCE: AN EstSSR. Institut fiziki i astronomii. Trudy*, no. 23, 1963. Issledovaniya po lyuminestsentsii (Research in luminescence), 210-215

TOPIC TAGS: luminescence, electroluminescence, low frequency electroluminescence, square wave luminescence excitation, phosphor, sulfide phosphor

ABSTRACT: In a previous work (K.-S.K. Rebane, E. K. Tal'viste, Trudy* IFA AN ESSR, no. 21, 257, 1962), the authors described the difference in the build-up rates of a series of electroluminescence pulses, corresponding to the rise and fall of the voltage on an opaque electrode of square-wave low-frequency (1-5 cps). For the further investigation of this phenomenon, electroluminescence capacitors were designed with a ZnS-Cu, Al electrophosphor and electrodes of conducting glass. By means of an NGPK-3 generator and various switching devices, electroluminescence excitation was achieved by square-wave voltage in a frequency interval of 0.1-100 cycles/second. The duration of the leading edge of the pulse was adjusted within limits of 10-500 microseconds. The build-up curves were photographed from the screen of a S1-4 oscilloscope, operating with a supplementary triggering device.

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ACCESSION NR: AT4020806

The authors used unipolar voltage pulses of both polarities as well as bipolar voltage pulses. In the latter case, the voltage was fed to the capacitor in a balanced state with respect to the ground or with one grounded electrode. An attempt is made to explain the difference in the rate of build-up of brightness waves, corresponding to the different half-cycles of the voltage, as the result of the formation in the crystals, at the beginning of the process, of an unbalanced volumetric polarization charge with a large relaxation time constant. In this article, the authors make absolutely no allowance for the ionization tunneling mechanism of the glow centers, although, as they admit, it is possible that this mechanism also plays a certain role in luminescence build-up. Orig. art. has: 3 figures.

ASSOCIATION: INSTITUT FIZIKI I ASTRONOMII AN EstSSR (Institute of Physics and Astronomy AN EstSSR)

SUBMITTED: 10Dec62 DATE ACQ: 07Apr64 ENCL: 00

SUB CODE: PH NO REF SOV: 006 OTHER: 003

Card 2/2

ACCESSION NR: AT3013090 S/2613/62/000/021/0247/0256

AUTHOR: Rebane, K.-S. K.

TITLE: Stationary luminescence in ZnS-type phosphors. Excitation valence band-electron traps

SOURCE: AN EstSSR. Institut fiziki i astronomii. Trudy*, no. 21, 1962, 247-256

TOPIC TAGS: phosphor, valence band, electron trap, luminescence, excitation density, luminescence brightness, kinetic model

ABSTRACT: Stationary luminescence excited by transitions of valence electrons to the trapping state of electrons in the forbidden zone was examined, and dependence of stationary luminescence on temperature and the excitation density was investigated. The zone model for calculating valence bandtrap level excitation is given (see Fig. 1 on Enclosure). Equations for hole and electron concentration variation are written and solved for luminescence quanta quantity I on the basis of two models: that of Schön-Klasens and Lambe-Klick. These yield

$$I = \frac{1}{1 + \frac{\delta_1}{\delta}\frac{\beta_1}{\beta}\frac{w}{w_1}}\,a.$$

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ACCESSION NR: AT3013090

for the Schön Klasens model, and

$$I' = \frac{1}{1 + \frac{\delta}{\delta_1}\frac{\beta}{\beta_1}\frac{w_1}{w}}\alpha.$$

for the Lambe-Klick model. The luminescence brightness dependence on excitation density and temperature is shown to be a strong function of the selected kinetic model. Orig. art. has: 18 equations and 3 figures.

ASSOCIATION: AN EstSSR. Institut fiziki i astronomii (AN EstSSR. Institute of Physics and Astronomy)

SUBMITTED: 15Mar62 DATE ACQ: 11Sep63 ENCL: 01

SUB CODE: PH NO REF SOV: 004 OTHER: 004

Card 2/3

S/613/61/000/017/006/011
D051/D113

24.3500 (1137, 1136, 1163)

AUTHOR: Rebane, L.A.

TITLE: On the interaction of luminescence centers during concentration and temperature quenching processes in NaCl-Ag

SOURCE: Akademiya nauk Estonskoy SSR. Institut fiziki i astronomii. Trudy, no. 17, 1961. Issledovaniya po lyuminestsentsii, 87-92

TEXT: On the basis of measurements of the temperature behavior of the 250 mμ emission band in NaCl-Ag, the possible character of interaction between the luminescence centers in this phosphor is discussed. The study continues previous investigations (L.A.Rebane, Trudy, IFA AN ESSR, No. 15, 56, 1961) devoted to the effect of Ag-concentration on temperature quenching of the centers I and II in NaCl-Ag and NaBr-Ag. In the present case, the temperature quenching of the luminescence centers I in NaCl-Ag was measured by calculating the areas below the emission bands of these centers, the bands being recorded at various temperatures. The obtained results confirm that the

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On the interaction ...

S/613/61/000/017/006/011
D051/D113

Ag-concentration affects the temperature behavior of the luminescence yield of the centers I in NaCl-Ag. Explanations for this effect are given. The location of the maxima of the NaCl-Ag emission bands does not depend on concentration. In the studied temperature range (290-540°K), the energy corresponding to the location of the band maximum E_m diminished in proportion to the temperature T. For the centers I in NaCl-Ag, $\Delta E_m/\Delta T$ was equal to (0.07 ± 0.01) eV per 100 degrees. The change in halfwidth was in proportion to $\sqrt{T}$ and amounted to about 0.03 eV per 100 degrees. F.D.Klement and D.Gluzkater are thanked for help rendered. There are 3 figures. The English-language reference is: P.Johnson, F.Williams, J.Chem.Phys.,18, 1477, 1950.

SUBMITTED: April 17, 1961

Card 2/2

L 10380-67 EWT(1) IJP(c)
ACC NR: AP7003066 SOURCE CODE: UR/0023/66/000/002/0301/0302

AUTHOR: Rebane, L. 34

ORG: Institute of Physics and Astronomy, Academy of Sciences Estonian SSR (Institut fiziki i astronomii AN EstSSR) P

TITLE: Isotopic shift in the luminescence spectrum of a KBr-O_2^- crystal

SOURCE: AN EstSSR. Izvestiya. Seriya fiziko-matematicheskikh i tekhnicheskikh nauk, no. 2, 1966, 301-302

TOPIC TAGS: luminescence spectrum, crystallography

ABSTRACT: An earlier article by the author and K. REBANE on the low-temperature (4.2° K) luminescence spectra of the molecular impurity O_2^- in a KBr crystal found weak lines whose position relative to the principal peaks in the vibration series shifted from group to group approximately according to a linear law. The suggestion was made that these lines are caused by the presence in the crystal of O_2^- molecules in which one of the O^{16} atoms has been replaced by an O^{18} isotope. The present article describes further experiments which were conducted to check this theory. The author thanks Ye. F. GROSS for letting him work in his laboratory, S. A. PERMOGOROV whose apparatus was used for some of the measurements, and T. SAAR for his assistance in conducting an experiment. Orig.art. has: 1 formula and 1 table /JPRS: 39, 040/

SUB CODE: 20 / SUBM DATE: 21Feb66 / ORIG REF: 002 / OTH REF: 002

Card 1/1 JC

0925 2004

L 20543-66

ACC NR: AP6012067 SOURCE CODE: UR/0023/65/000/002/0309/0312

AUTHOR: Rebane, K.; Rebane, L.

ORG: Institute of Physics and Astronomy, AN EstSSR (Institut fiziki i astronomii AN EstSSR)

TITLE: Low-temperature emission spectra of oxygen in alkali halide crystals

SOURCE: AN EstSSR. Izvestiya. Seriya fiziko-matematicheskikh i tekhnicheskikh nauk, no. 2, 1965, 309-312

TOPIC TAGS: emission spectrum, luminescence spectrum, crystal impurity, oxygen, photomicrography, alkali halide, cryogenica

ABSTRACT: The liminescence spectra of alkali halide crystals activated by oxygen have a vibrational structure which is clearly pronounced even at room temperature. At helium temperatures each of the vibrational bands of the spectrum is found to possess a "fine structure." In order to study this structure further and ascertain its nature, the authors made a more detailed measurement of luminescence spectra at a temperature of 4.2° K. The authors report finding a number of new spectra details (from three to ten clear peaks) and attribute the fine structure mainly to the interaction of the electron transition in the impurity molecule O_2^-, with the crystal vibrations distorted by it. The article presents photomicrograms of the emission spectra of NaBr - O_2, KCl - O_2, and KBr - O_2, as well as a table of the positions of all recorded peaks. The authors thank Ye. F. Gross and coworkers at the laboratory

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L 20543-66
ACC NR: AP6012067

for making possible the carrying out of the measurements. Further thanks is extended to B. P. Zakharchene for valuable advice and to I. I. Takhistovaya for participation in the measurements. Orig. art. has: 3 figures and 3 tables. [JPRS]

SUB CODE: 20 / SUBM DATE: 08Jun65 / ORIG REF: 003 / OTH REF: 006

Card 2/2

REBANE, L.A.

"A beacon light" of the communication workers of the Estonian railroad. Avtom., telem.i sviaz' 6 no.4:23-25 Ap '62. (MIRA 15:4)

1. Nachal'nik sluzhby signalizatsii i svyazi Estonskoy dorogi.
(Estonia--Railroads--Signaling)

L 2360-66 EWT(1)/ IJP(c)

ACCESSION NR: AT5021775 UR/2613/64/000/028/0045/0053

AUTHOR: Rebane, L. A. 44,55

TITLE: Spectral characteristics of mixed phosphor NaCl·KCl-Ag 31,44,55

SOURCE: AN EstSSR. Institut fiziki i astronomii. Trudy, no. 28, 1964. Issledovaniya po lyuminestsentsii (Research on luminescence), 45-53

TOPIC TAGS: phosphor, sodium chloride, potassium chloride, emission spectrum, excitation spectrum/ SF 4 monochromator

ABSTRACT: The emission and excitation spectra of NaCl·KCl-Ag phosphors were investigated as a function of the ratio NaCl/KCl. The phosphors were prepared in the form of polycrystalline cakes by rapid cooling of the salt and activator mixture melt. The AgCl content was 2×10^{-2} mol%, whereas the NaCl and KCl contents were variable. The specimens were excited by hydrogen lamps through monochromator-spectrophotometer SF-4. The recorded emission spectra show that decreasing the sodium chloride content shifts the emission bands towards the long wavelength side of the spectrum, at the same time increasing their half-widths. This effect is shown in Fig. 1 on the Enclosure, where δ is the half width of the emission bands. To study the effect of the wavelength of the excitation source on the emission spectra, the specimens were tested at three wavelengths with 90% NaCl content. The

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L 23[illegible]-66

ACCESSION NR: AT5021775

9

results show that the longer wavelength irradiation shifts the emission spectra towards the longer wavelengths. To understand the crystal structure better, experiments were performed at 100K temperatures. A new emission band with a 3.8 eV maximum was observed at this temperature. "The author thanks F. D. Klement for evaluating the work and O. I. Sil'd for valuable suggestions." Orig. art. has: 5 figures.

ASSOCIATION: Institut fiziki i astronomii, AN EstSSR (Institute of Physics and Astronomy, AN EstSSR)

SUBMITTED: 14Jan64 ENCL: 01 SUB CODE: IC, SS

NO REF SOV: 011 OTHER: 001

Card 2/3

L 2360-66
ACCESSION NR: AT5021775

ENCLOSURE: 01

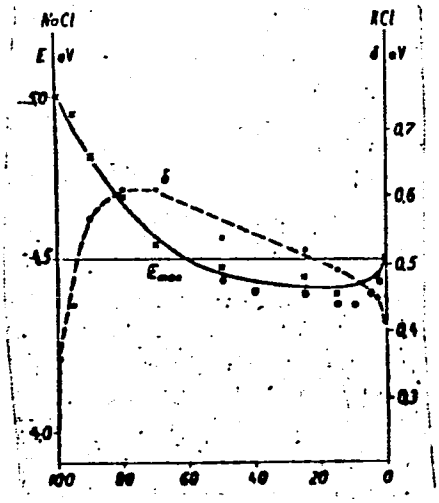

Fig. 1. Location of the maxima (E_{max}) and half-width (δ) of NaCl·KCl-Ag emission bands as a function of base component content: x - λ_{excit} = 220 nm, o - λ_{excit} = 230 nm

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S/058/62/000/006/037/136
A061/A101

AUTHORS: Lushpa, R. G., Rebane, L. A.

TITLE: Behavior of spectra and yield with concentration in silver-activated alkali-halide phosphors

PERIODICAL: Referativnyy zhurnal, Fizika, no. 6, 1962, 54, abstract 6V374 ("Tr. In-ta fiz. i astron. AN EstSSR", 1961, no. 14, 87 - 110, English summary)

TEXT: The changes of spectrum characteristics and radiative quantum yield of crystal phosphors on NaBr, NaCl, and KCl base when activated by Ag in different concentrations have been investigated. In the case of low Ag concentrations, the centers containing one Ag^+ ion are responsible for luminescence. At an increase of the activator concentration, luminescence centers appear which contain two Ag^+ ions, and the radiative quantum yield of centers of the former type drops so much that the sum of the quantum yields of the two centers remains constant. One more type of centers, the nature of which has not been studied, has been discovered at high Ag concentrations.

[Abstracter's note: Complete translation]

N. Maksimova

Card 1/1

S/058/62/000/008/045/134
A061/A101

AUTHOR: Rebane, L. A.

TITLE: Effect of the activator concentration on the temperature quenching of luminescence in some silver-activated alkali halide phosphors

PERIODICAL: Referativnyy zhurnal, Fizika, no. 8, 1962, 43, abstract 8V297 ("Tr. In-ta fiz. i astron. AN EstSSR", 1961, no. 15, 56 - 80; summary in English)

TEXT: The change with temperature of the quantum yield of luminescence in NaCl-Ag, NaBr-Ag, and KCl-Ag phosphors with different activator content has been investigated. The results are evaluated taking the possible interaction between luminescence centers of first and second kind into account.

[Abstracter's note: Complete translation]

Card 1/1

REBANE, L.A.

Concentration and temperature quenching of luminescence in some alkali halide phosphors activated by silver. Izv.AN SSSR. Ser. fiz. 25 no.3:345-346 Mr '61. (MIRA 14:2)
(Phosphors) (Alkali halides)

S/613/61/000/014/005/019
D207/D303

AUTHORS: Lushpa, R.G., and Rebane, L. A.

TITLE: Effect of silver activator concentration on the spectra and yield of alkali-halide phosphors

SOURCE: Akademiya nauk Estonskoy SSR. Institut fiziki i astronomii. Trudy. No. 14, 1961. Issledovaniya po lyuminestsentsii, 87-110

TEXT: The authors report an investigation and interpretation of the changes on spectral characteristics and quantum yield of NaBr: Ag, NaCl:Ag and KCl:Ag occurring on increase of the silver content. The main results of the work were presented at the Ninth All-Union Conference on Luminescence in June, 1960, and a summary was published earlier by L. A. Rebane (Ref. 1: Trudy IFA AN ESSR, no.11, 193, 1960). This work is a continuation of a similar study by the same author of NaCl:Ag with 0.01 - 3.0 mol.% Ag (Ref. 2: Trudy IFA AN ESSR, no. 12, 49, 1960). NaCl:Ag and NaBr:Ag were prepared either as monocrystals (by the Czochralski method) or as polycrystal-

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Effect of silver activator ...

line ingots (by solidification of melt). Monocrystal series had 0.01, 0.1, 0.3, 0.6, 1.0, 1.3, 1.6, 2.0 and 3.0 mol. % AgBr in melt; polycrystal series had 1, 3, 7, 10, 15, 20, 25 and 30 mol.% AgBr. KCl:Ag phosphors were prepared from KCl and AgCl which were poorly miscible; only the following AgCl concentrations were used: 0.01, 0.1, 1.0 and 3.0 mol.% in melt. Absorption, emission and excitation spectra were recorded. In the case of monocrystals the technique used previously (Ref. 2:Op. cit.) was employed, except that the absorption spectra of NaBr:Ag with 1.3 and 1.6 mol.% AgBr were determined employing Ye. K. Putseyko's technique (Ref. 7: Optika i spektroskopiya, 3, 665, 1957). G. Fonda's method (Ref.8: J. Phys. Chem., 43, 574. 1939) was used to determine the quantum yield of polycrystals in powdered form. Excitation was obtained from a hydrogen lamp ВСФУ-3 (VSFU-3) and a monochromator СФ-4 (SF-4). The luminescence and the reflected exciting light were analyzed with the same monochromator SF-4 and a photomultiplier ФЭУ-18 (FEU-18). NaBr:Ag is hygroscopic; to keep it dry it was smeared with a thin layer of wax. The principal result of the work was establishment of the existence of three types of luminescence centers

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Effect of silver activator ...

in all the phosphors: Type I (one Ag^+ ion), type II (two AG^+ ions), type III (probably Ag atom). As the concentration of silver increased, type I centers were formed first, then type II and finally type III. In KCl:Ag the presence of one or the other type of center depended on previous heat treatment. Acknowledgment is made to F. D. Klement who suggested the subject and directed the work. There are 14 figures, 4 tables and 27 references: 19 Soviet-bloc and 9 non-Soviet-bloc. The 4 most recent references to the English-language publications read as follows: H. Etzel and J. Schulman, J. Chem. Phys., 22, 1549 (1954); R. Onaka, Science of Light (Tokyo), 3, 156 (1955); Y. Uchida, Y. Nakai and T. Tomotika, J. Opt. Soc. Am., 47, no. 3, 246 (1957); J. Schulman and E. Claffy, Phys. Rev., 108, 1398 (1958).

SUBMITTED: July 30, 1960

Card 3/3